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ATTRITION IN ORDNANCE SCHOOL COURSES

Milton H. Maier

Army Behavior and Systems Research Laboratory
Arlington, Virginia

September 1972

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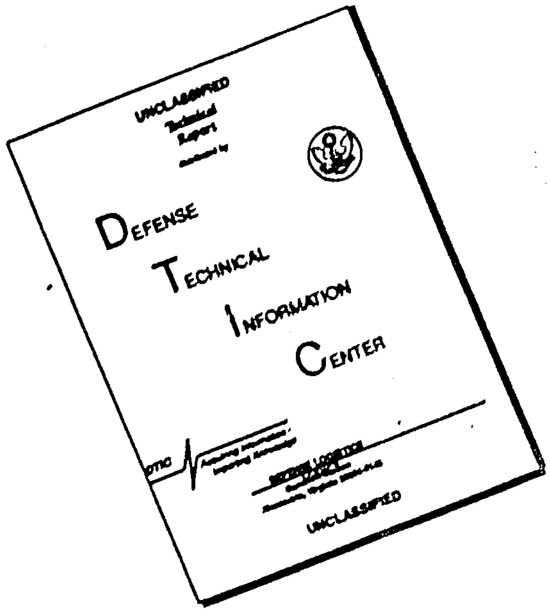

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Technical Research Note 231

ATTRITION IN ORDNANCE SCHOOL COURSES

Milton H. Maier

MILITARY SELECTION RESEARCH DIVISION

B E S R L

U. S. Army

Behavior and Systems Research Laboratory

September 1972

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13. ABSTRACT

The Differential Classification Work Unit of the Behavior and Systems Research Laboratory has as a primary objective the continuing conduct of research to maintain and improve the effectiveness of the Army Classification Battery (ACB). As a part of the overall effort, the Work Unit provides assistance to Army operational agencies in developing efficient scoring, reporting, and utilization techniques. The present Technical Research Note deals with the problems of attrition at the Army Ordnance School and reports on a segment of a broader research effort to find ways of reducing attrition among ordnance trainees.

Scores on the ACB predictors and written and performance tests given during three Ordnance courses were subjected to analyses to attempt to account for failure to complete training satisfactorily. Specific objectives of the present analysis were to determine 1) failure rates during the course, 2) consistency of grades at different reporting periods, and 3) consistency of measured aptitudes and course performance. The three courses selected (because of high failure rates) for analysis were: Machinist (44E), Small Arms Repair (45B), and Fuel and Electrical System Repair (63G). Scores on written and performance tests given at the end of each reporting period in the courses were analyzed in relation to each other, to final course grade, and to ACB test scores. Failure rates on the test during and at end of course were ascertained.

Results of the analyses showed that ACB tests had the expected degree of effectiveness as predictors of trainee performance (correlation coefficients in the .50's and .60's). Failure rates in most written tests were high, sometimes exceeding 50% of

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II

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13. ABSTRACT - Continued

those completing the course. Failure rates on performance tests were low--under 5%--except in the Machinist course (over 20% level). Obtained interrelationships between written and performance tests were inconsistent in respect to individuals passing and failing, as was also the case for failure rates on tests at early and late reporting periods.

Reevaluation of written tests given at the end of each period may be of greater utility in reducing attrition. A subsequent research phase will be directed to examining the relationships among aptitude tests, training grades, and performance on job tasks in an effort to gain understanding of how these measures function in the total process of classifying, training, and utilizing Army enlisted men.

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Technical Research Note 231

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ATTRITION IN ORDNANCE SCHOOL COURSES

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BESRL Technical Research Reports and Technical Research Notes are intended for sponsors of R&D tasks and other research and military agencies. Any findings ready for implementation at the time of publication are presented in the latter part of the Brief. Upon completion of a major phase of the task, formal recommendations for official action normally are conveyed to appropriate military agencies by briefing or Disposition Form.

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FOREWORD

The DIFFERENTIAL CLASSIFICATION Work Unit applies psychological measurement methods to enable the Army to make best use of the different skills and aptitudes of its enlisted personnel through increasingly accurate and differentiated measures of individual potential. Research is conducted to maintain and improve the effectiveness of the Army Classification Battery and related techniques and to determine how different conditions--changes in training programs and job content and environment, for example--may interact with classification test measures and thus affect the basis for utilization of the enlisted input.

As a part of its overall effort, the Work Unit provides assistance to the Army's operational agencies in developing efficient scoring, reporting, and utilization techniques. Recommendations are based in large part on research and systems analysis of the entire process of classifying, training, and utilizing enlisted men in the various Military Occupational Specialties.

The present Technical Research Note deals with problems of attrition at the Army Ordnance School, and presents an analysis of scores on Army Classification Battery predictors and written and performance tests given during three Ordnance courses in an effort to account for failure to complete the training satisfactorily.

The entire research work unit is responsive to special requirements of the Deputy Chief of Staff for Personnel and the U. S. Continental Army Command, as well as to objectives of Army RDT&E Project 2Q062106A722, "Selection and Behavioral Evaluation," FY 1972 Work Program.

J. E. UHLANER, Director
Behavior and Systems
Research Laboratory

ATTRITION IN ORDNANCE SCHOOL COURSES

BRIEF

Requirement:

To analyze a sequence of grades on tests in Ordnance school courses in relation to failure rates and Army Classification Battery test scores as a segment of research to reduce attrition among Ordnance trainees.

Procedure:

Scores on written and performance tests given at the end of each reporting period in three Ordnance school courses--Machinist (44E), Small Arms Repair (45B), and Fuel and Electrical System Repair (63G)--were analyzed in relation to each other, to final course grade, and to ACB test scores. Failure rates on written and performance tests during and at end of course were ascertained.

Findings:

ACB tests had the expected degree of effectiveness in predicting trainee performance (correlation coefficients in the .50's and .60's). Tests in the aptitude area prerequisites for the courses were the best predictors for the appropriate courses.

Failure rates in most written tests were high, sometimes exceeding 50 percent of those completing the course.

On performance tests, failure rates were low, under 5 percent except in the Machinist course in which over 20 percent failed some tests.

Written and performance tests were inconsistent in respect to individuals passing and failing.

Failure rates on tests at early and late reporting periods were also inconsistent.

Utilization of Findings:

The generally constant effectiveness of the ACB tests supports their continued use as prerequisites. Current aptitude areas for each course are appropriate.

However, raising the prerequisite score would lower attrition only slightly and would reduce the eligible manpower pool. A more fruitful approach to reducing attrition is to reevaluate the written tests given at the end of each reporting period. These tests, which are a prime determiner of pass-fail, may cover more difficult skills and concepts than are required at the entry level.

ATTRITION IN ORDNANCE SCHOOL COURSES

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FIGURES

THE PROBLEM

The present study was conducted as part of a broader research effort to find ways of reducing attrition in Ordnance School courses. In this effort, attrition is viewed not as an isolated phenomenon but as one aspect of the entire process of classification, training, and utilization of enlisted men. For this reason, the research deals with the interrelationships of aptitude tests, training grades, and performance on the job.

Basic to an understanding of the process of assigning men to training is information on the predictive accuracy of the aptitude tests and on the interrelationships of the achievement measures entering into evaluations of performance in the training course (including failure to complete the course satisfactorily). Components of course grade include written and performance tests given during and at the end of the course. The present Technical Research Note 231 covers an analysis of the interactions between Army Classification Battery test scores and the written and performance tests given at successive reporting periods in several Ordnance courses. The aim is to account for failure to complete the training satisfactorily.

An important function of achievement tests given during training is to determine which students have developed an adequate level of skills and knowledge. Achievement tests are also used to make distinctions among those passing--for example, to assign grades of A, B, or C or to identify top students in a class. The measurement instruments used are critical in assessing the students. The tests must be relevant to the material taught (a matter of expert judgment) and they must make adequate and reasonable discriminations among different levels of achievement. To make an intelligent judgment about the adequacy and reasonableness of tests applied in a course, an analysis of the scores is required. In the present phase of the research, the achievement test scores--written and performance--obtained at the end of each reporting period in three job training courses were analyzed in relation to each other, to final course grade, and to aptitude test scores obtained prior to training. The research was designed to provide data about the ways the tests are actually functioning. The results can be evaluated in the context of the instructional model on which the courses are based. The question is whether the results are in keeping with the objectives that guided the development of the courses or whether there is some dissonance between observed and expected outcomes of training.

OBJECTIVES

The specific objectives of the present analysis were to determine 1) failure rates during the course, 2) consistency of grades at different reporting periods, and 3) consistency of measured aptitudes and course performance. Failure rates during instruction were examined separately for written and performance tests and for each reporting period and at the end of the course. The analysis was also designed to show 1) whether written and performance tests provide similar information about the skills and knowledge of the trainees, 2) whether the same or different trainees tend to do well during the different reporting periods, and 3) whether the aptitudes required are relevant to success in the various stages of instruction.

METHOD

Courses were selected for analysis because they had high failure rates, input was large enough to provide an adequate sample, and course content had not been recently revised and was not expected to be changed in the near future. The three courses selected were:

Machinist, 44E
Small Arms Repair, 45B
Fuel and Electrical System Repair, 63G

The samples consisted of men who graduated in January through December 1969, and included only inductees and enlistees who had recently begun their tour of duty. Reservists on active duty for six months and men who had had other extensive Army training and experience were excluded if they could be identified. The results, then, apply to new Army recruits assigned to their initial job training course; attrition is more of a problem with recruits than with reservists on active duty.

Academic failure rates provided by the Ordnance School are shown below. These figures are based on the entire input, including reservists.

	Course		
YEAR	MACHINIST (44E)	SMALL ARMS REPAIR (45B)	FUEL AND ELECTRICAL SYSTEM REPAIR (63G)
1968	11%	12%	8%
1969	8%	6%	4%
1970	12%	5%	2%

The fluctuating failure rates suggest that results might be different for different time periods. The samples for each course were divided into early and late halves and each half was analyzed separately.

The Machinist course had nine reporting periods, with nine written and six performance tests. The Small Arms Repair course also had nine reporting periods with nine written and four performance tests. The Fuel and Electrical System Repair course had two grading plans, one used until March 1969 (called 63G-Old in the accompanying tables) and the second after that (called 63G-New). The earlier plan had 12 reporting periods, with 12 written and six performance tests. In all courses, the performance tests were more heavily weighted in the final course grade than the written tests. An exception is the earlier version of the Fuel and Electrical System Repair course where the written examinations and quizzes carried 57 percent of the weight in the final grade; in the revised grading plan, the written portions had only 38 percent of the weight. Grading plans for the courses are presented in Appendix A.

Mental characteristics were measured by the Army Classification Battery (ACB) and the Armed Forces Qualification Test (AFQT). The ACB provides comprehensive measurement of differential aptitudes; the tests are described in Table 1. The AFQT is a measure of general mental ability used as an initial screen to determine qualification for military service.

RESULTS

Observed failure rates in these samples were 29 percent for the Machinist course, 20 percent for Small Arms Repair, and 11 percent and 18 percent for the old and new versions of the Fuel and Electrical System Repair course, respectively. These figures are higher than those reported by the school for academic reasons only.

In determining which reporting periods made the largest contribution to the failure rates, all individuals failed during the course were omitted from the sample to keep the basis of comparison constant. Only those men completing the course were used in measuring the difficulty of the tests. Some of these men were failed at the end of the course, but they did finish the course and scores on all tests were available for them. Difficulty of the tests was determined by finding the percentage of men who failed each one.

Results for the Machinist course are presented in Figure 1. The first two written tests and the first performance test given during the course proved very easy, with less than 10 percent of the trainees in the sample receiving a failing grade. The other tests were harder, except the final written test, which was failed by slightly under 10 percent. The final performance test, though, was difficult with about 26 percent failing.

Table 1

TESTS IN THE ARMY CLASSIFICATION BATTERY
1. Verbal Test, VE (50 items). Each item requires the examinee to select the correct synonym for the underlined word in a short sentence.
2. Arithmetic Reasoning, AR (40 items). Each item is a reasoning problem involving application of arithmetic processes.
3. Pattern Analysis, PA (50 items). A two-dimensional pattern with numbered lines is presented along with the corresponding three-dimensional figure made by folding the pattern along the indicated lines. The examinee is required to identify the lettered edge of the figure corresponding to a numbered line in the pattern.
4. Mechanical Aptitude, MA (45 items). Each item includes a figure illustrating some physical principle.
5. Army Clerical Speed, ACS. In Part I, Number Reversal (60 items), the examinee indicates whether the second number in each item is exactly the reverse of the first. In Part II, Coding (50 items), a key word is followed by a number that is associated with it. Each item presents a word followed by all numbers in the key. The examinee is to pick the number corresponding to the word in the key.
6. Army Radio Code, ARC--an auditory test, recorded on tape. The examinee is taught the code signals for three letters I, N, and T. Immediately after the learning exercises, a test of 150 items is given.
7. Shop Mechanics, SM (40 items). Each item presents a drawing illustrating some mechanical principle or tool usage.
8. Automotive Information, AI (40 items). Each item is a question about the identification or operation of automobile parts.
9. Electronics Information, ELI (40 items). The examinee is required to associate pictured objects in terms of how they function electronically, and in verbal items to demonstrate his knowledge of electronics principles.
10. Classification Inventory, CI (125 items). The CI consists of self-description items in which the examinee indicates his personal background, attitudes, self-evaluation, and experiences.
11. General Information Test, GIT (50 items). Questions cover objective items of information about various avocational pursuits.

If the minimum passing grade is designed to assess the standards that every trainee should attain, then either most of the later tests were too difficult or the instruction did not bring a large percentage of trainees up to standard. Since failure rates on all written and performance tests were based on the same men, the failure rates were primarily a function of the tests themselves and not of different men taking the tests. Of course, performance of individuals does vary across time and may have had a slight effect on failure rates. The test means for all courses are presented in Appendix B.

The percentage of failures in the Small Arms Repair course (45B) showed a different pattern than in the Machinist course (Figure 2). The earlier written tests were difficult, with 36 percent failing. In the sixth and seventh reporting periods, failure rate dipped below 10 percent. The final written examination was extremely difficult, with 60 percent failing. Note that all the trainees failing the final completed the course, although not all were successful. The performance tests were considerably easier, with a maximum of 18 percent failing the performance test for period 6. Most failing scores in the Small Arms Repair course occurred on written tests, relatively few on performance tests.

The failure rates in both versions of the Fuel and Electrical System Repair course also showed large differences between written and performance tests. Tests for Course 63G-Old, shown in Figure 3, started easy, and then became more difficult for the trainees until period 8, when failure rate fell to about 20 percent. Again, the final written test was difficult. Course 63G-New started difficult and ended even more so, as shown in Figure 4. About half failed the first written test and 85 percent failed the final one. The performance tests, in contrast, had almost no failures. In the new course, only the performance test for period 6 was failed; no one failed the performance tests for periods 1, 3, 5, 7, and 8.

Analysis of failure rates for the written and performance tests indicated that written tests were more difficult than performance tests in the Small Arms Repair and Fuel and Electrical System Repair courses, while in the Machinist course written and performance tests were of more equal difficulty. The performance tests are so heavily weighted in computing final course grade that the overall failure rates are largely a function of performance tests. In Course 63G-New, the failure rate was only 18 percent even though 85 percent failed the final written test. As shown in Appendix A, 27 percent of the weight for the final grade in this course is assigned to the written examinations, while 62 percent is assigned to the performance tests. The other 11 percent goes to graded quizzes. The effect was to assign a high constant to each trainee in 63G-New based on his performance scores. Variation between trainees was thus largely a function of the written tests. The same effect was noted for the Small Arms Repair course, but not for the Machinist course. In the Machinist course, both the overall written and performance failure rates were high, and the performance tests did discriminate between failures and passers.

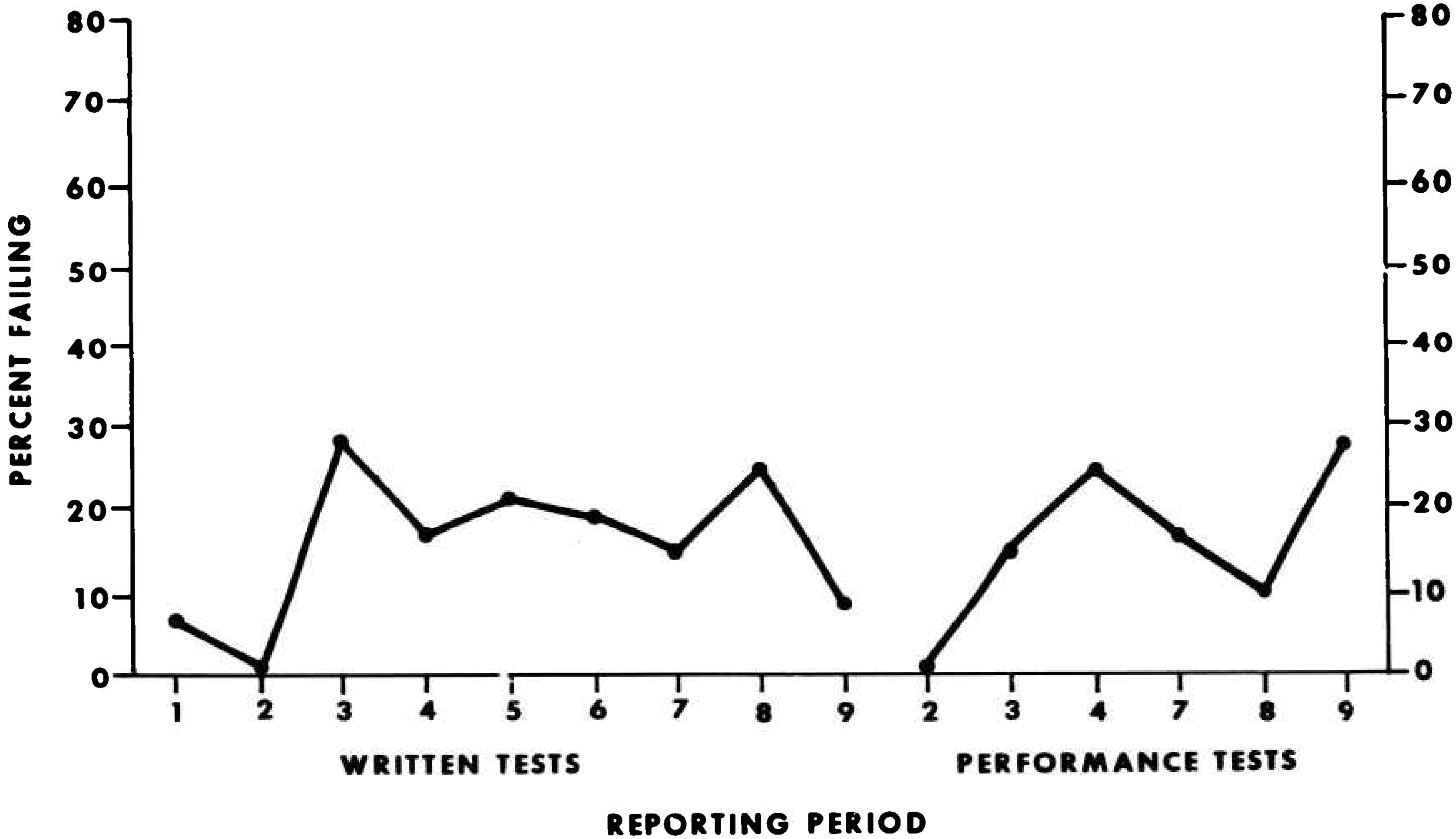

Figure 1. Failure rate at each reporting period in Machinist Course (44E)

The proportion of failures provides information on how difficult the test is, but the question still remained whether the same or different men tended to fail successive tests. The second objective of the analysis was to determine whether trainees tended to perform at a constant level or whether individuals' grades fluctuated from reporting period to reporting period. Another aspect was to determine whether trainees with high aptitude tended to do well in all reporting periods.

Analysis of consistency of performance focused on the training program itself: How do grades attained early in the course compare with those later on? How do grades on written tests compare with those on performance tests? Is there a shift in the relationships as training progresses?

The relationships between grades on the first and last written tests are presented in Table 2. The last test is defined as the one just preceding the end-of-course test. The final test covers all material from all reporting periods, while the last test covers only the material taught in the period immediately before the final. For example, the last test in the Machinist course covers reporting period 8, while the final test covers reporting period 9 and all preceding periods. Of the 330 trainees who completed the course, 79 failed the last written test, while only 9 failed the first. Six of these 9 also failed the last. Fifteen trainees scored 85-100 on the first test but failed the last. The figures shown for this course reflect a correlation coefficient of .51. The grades for the Small Arms Repair and the Fuel and Electrical System Repair course were considerably less consistent, as indicated by correlation coefficients of .29 and .30, respectively. In the Small Arms Repair course, 12 of 265 trainees scored 85-100 on the first test and failed the last. In the old form of the Fuel and Electrical System Repair course, failures on the first written test were not counted separately since there were only three. In the later form, the last written test was extremely difficult, with only 46 of 186 scoring 67 and above. In all the courses, there was considerable variation in performance between first and last written tests.

Consistency of grades on performance tests is shown in Table 3. The relationship was lower for performance tests than for written tests. Of the 32 men in the Machinist course who failed the last performance test, only eight scored below 79 on the first, while the remaining 24 scored 80 or above. In the Small Arms Repair course and the older form of the Fuel and Electrical System Repair course, a similar degree of relationship was found. In the new course, the two measures were statistically independent, as shown by the correlation coefficient of .01. The relative standing of the trainees on performance tests changed considerably between first and last testing periods. The mean coefficients presented in Appendi ^ show that those presented in Tables 2 and 3 are not atypical.

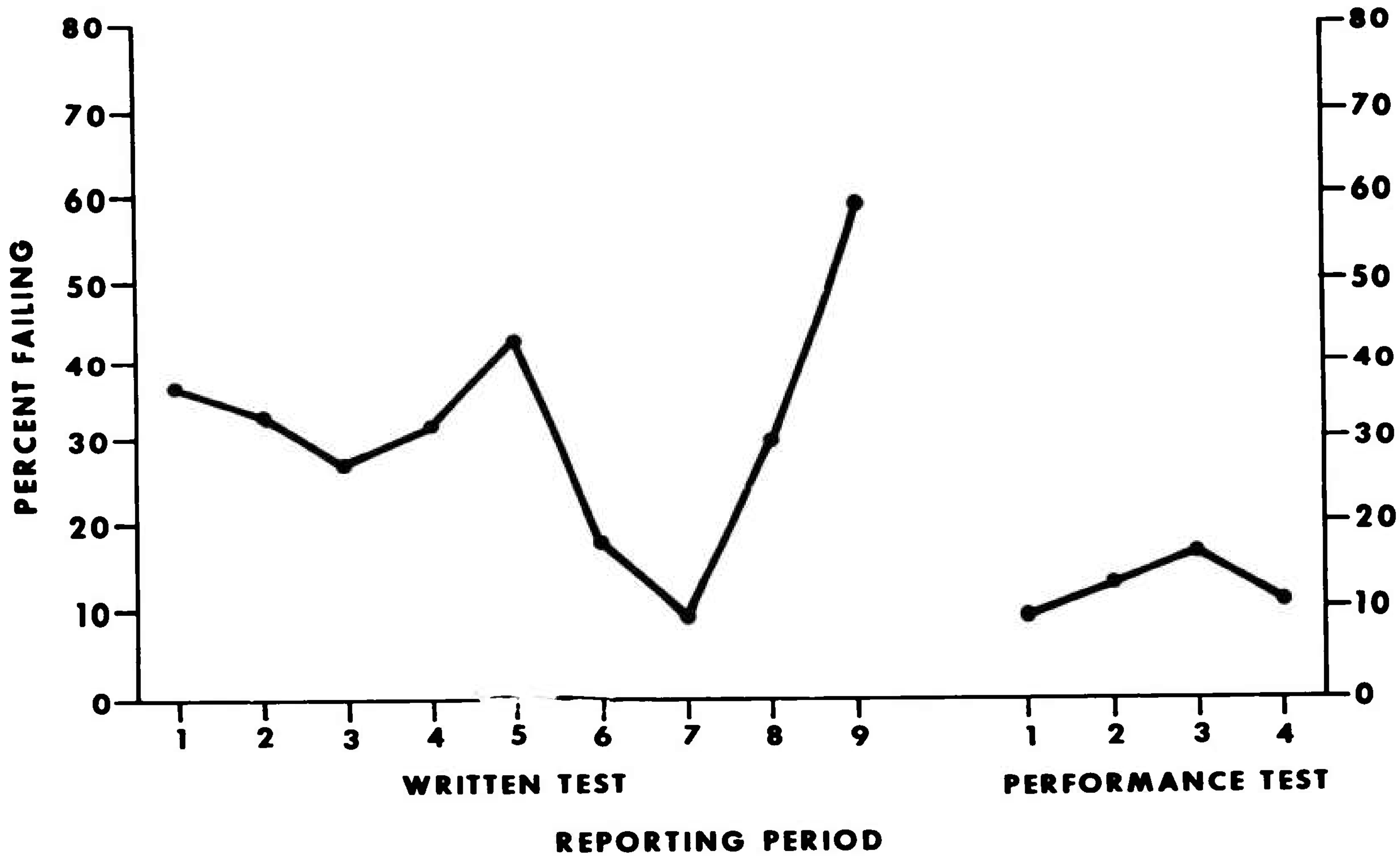

Figure 2. Failure rate at each reporting period in the Small Arms Repair Course (45B)

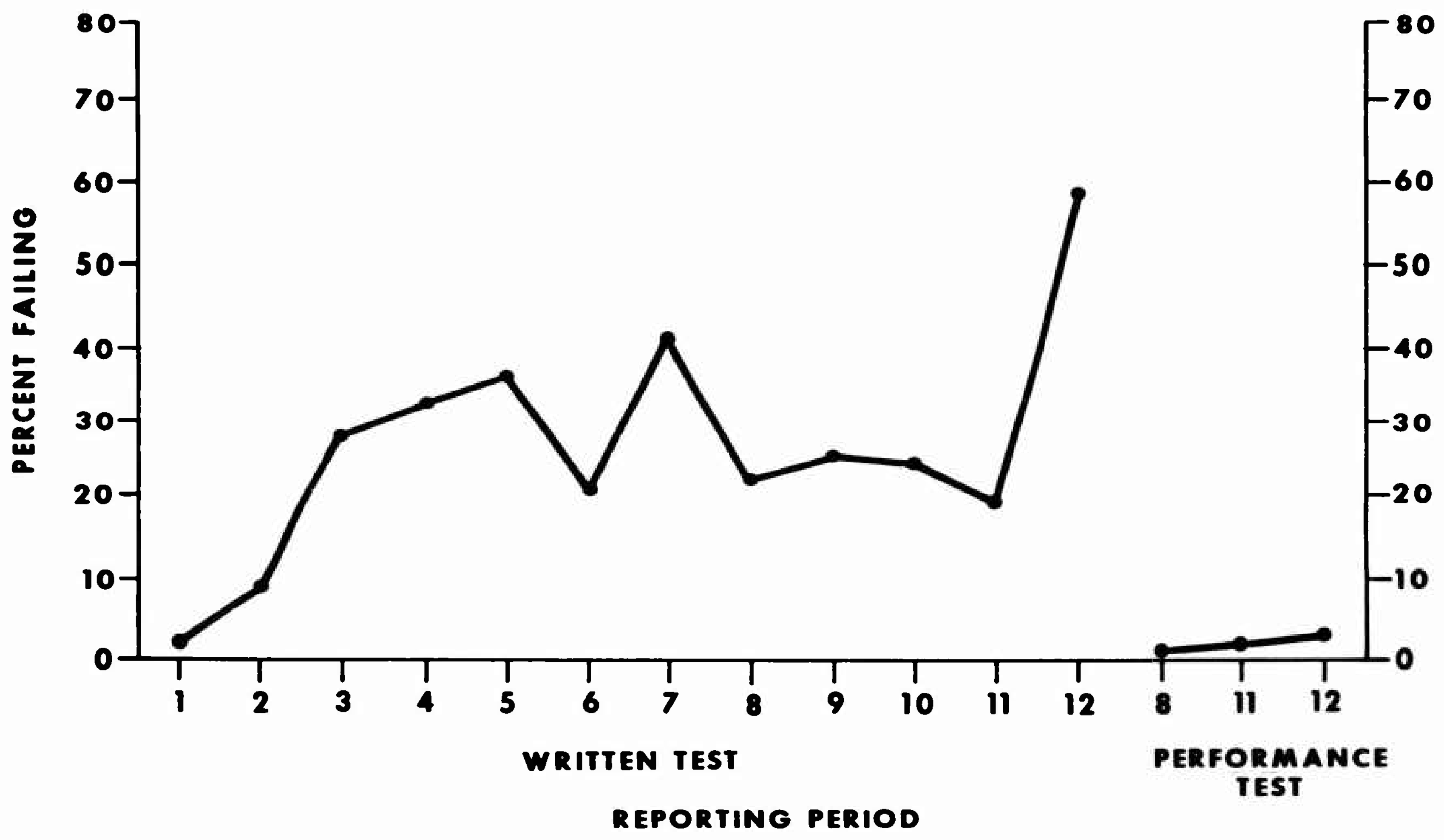

Figure 3. Failure rate at each reporting period in Fuel and Electrical System Repair Course--OLD (63G-Old)

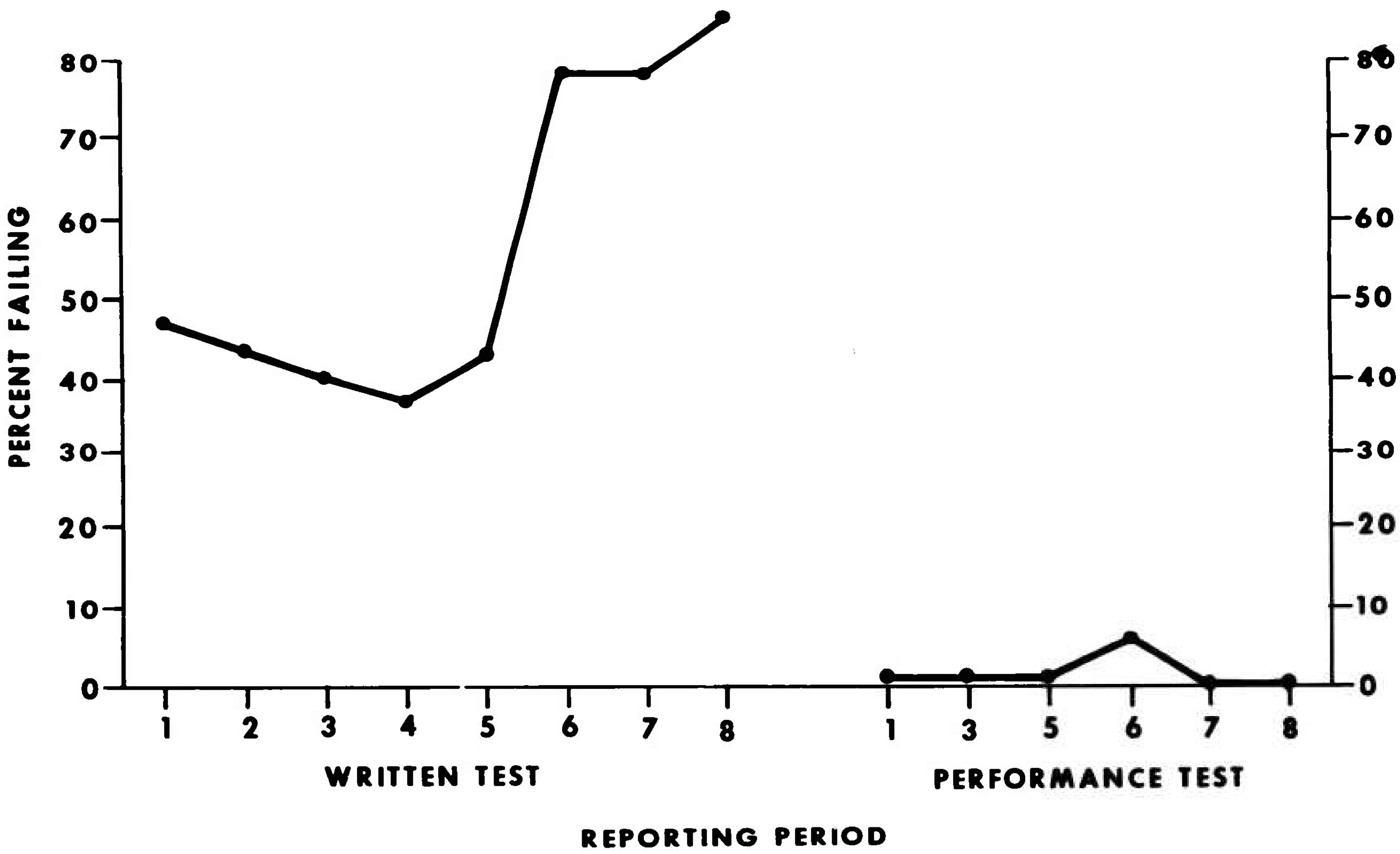

Figure 4. Failure rate at each reporting period in Fuel and Electrical System Repair Course--NEW (63G-New)

Table 2

RELATIONSHIPS BETWEEN FIRST AND LAST WRITTEN TESTS

Machinist Course (44E)

		First Written Test			
		Below 70	70-84	85-100	Total
Last Written Test	85 - 100	0	25	45	70
	70 - 84	3	104	74	181
	Below 70	6	58	15	79
	Total	9	187	134	330

r = .51

Fuel and Electrical System Repair Course (63G-Old)

		First Written Test			
		Below 77[a]	77-89	90-100	Total
Last Written Test	87 - 100	3	21	51	75
	70 - 86	17	38	29	84
	Below 70	10	17	12	39
	Total	30	76	92	198

r = .30

[a] Only 3 scores were below 70

Small Arms Repair Course (45B)

		First Written Test			
		Below 70	70-84	85-100	Total
Last Written Test	85 - 100	12	32	31	75
	70 - 84	41	43	33	117
	Below 70	32	29	12	73
	Total	85	104	76	265

r = .29

Fuel and Electrical System Repair Course (63G-New)

		First Written Test			
		Below 67	67-79	80-100	Total
Last Written Test	67 - 100	4	14	28	46
	53 - 66	21	15	24	60
	Below 53	40	30	10	80
	Total	65	59	62	186

r = .46

Table 3

RELATIONSHIP BETWEEN FIRST AND LAST PERFORMANCE TESTS

Machinist Course (44E)

		First Performance Test: Below 70[a]	80-89	90-100	Total
Last Performance Test	85 - 100	29	86	33	148
	70 - 84	43	92	15	150
	Below 70	8	19	5	32
	Total	80	197	53	330

r = .18

[a] Only one score was below 70

Fuel and Electrical System Repair Course (63G-Old)

		First Performance Test: Below 90[a]	90-96	97-100	Total
Last Performance Test	97 - 100[b]	15	34	69	118
	90 - 96	13	20	16	49
	Below 90	11	12	8	31
	Total	39	66	93	198

r = .26

[a] Only two scores were below 70
[b] Only four scores were below 70

Small Arms Repair Course (45B)

		First Performance Test: Below 80[a]	80-89	90-100	Total
Last Performance Test	85 - 100	14	35	44	93
	70 - 84	24	39	27	90
	Below 70	12	16	9	37
	Total	50	90	80	220

r = .26

[a] 19 scores were below 70

Fuel and Electrical System Repair Course (63G-New)

		First Performance Test: Below 88[a]	90-96	97-100	Total
Last Performance Test	98 - 100	16	28	24	68
	92 - 97	23	33	21	77
	Below[a] 92	11	17	13	41
	Total	50	78	58	186

r = .01

[a] No scores were below 70

Another measure of consistency of test scores is provided by a comparison of the final written and performance tests (Table 4). Since the final tests covered the entire course, their relationship with the other tests tended to be higher than that for tests limited to a single reporting period. The low correlation shown in Table 4 indicates that in the Machinist and Small Arms Repair courses final written and performance scores were quite independent. In both forms of the Fuel and Electrical System Repair course, however, written and performance tests did have a moderate relationship. In the Machinist course, only 17 of 329 failed the final written test, while 81 failed the final performance test. Of the 81 failures, 27 scored 85-100 on the final written test and only 8 failed it. Thus, the two final written and performance tests provided discrepant information about how capable the trainees were at the end of the course.

When correlation coefficients between written and performance tests for the same reporting periods were examined, the same low consistency was found for most periods. The mean correlation coefficients are presented in Appendix C.

Scores tended to fluctuate across time, as revealed in the analysis of the test scores for the separate reporting periods. Performance test scores were less consistent than written test scores. Most tests--written and performance--had high correlation with final course grades, the bulk of the coefficients being above .60 (Appendix C). One reason for the generally high correlation with final course grade was that each test was a contributor to the final grade and thus there was a part-whole relationship. Another reason was that almost all the intercorrelations were positive and there was some cumulative effect of the test scores, even if the tests for some reporting periods were relatively independent of those for other periods.

The next step in analyzing consistency of performance was to examine the relationship between ACB aptitude tests administered prior to training and achievement tests administered during training. The mean correlation coefficients of ACB with training period grades are presented in Appendix C; selected coefficients are discussed in the text. All coefficients have been statistically corrected, via the multivariate restriction model, to be estimates of the values that would be found for a representative unselected sample from the mobilization population.

Two assumptions made in interpreting correlation coefficients as showing the predictive accuracy of an aptitude test score are: 1) that the relationship between the predictor (ACB tests) and criterion (training grades) is essentially linear throughout the useful score range, and 2) that the errors of prediction have the same standard deviation for all levels of predictor scores. Scatterplots of aptitude scores with final course grade for each course revealed that the two assumptions were met in these data. The correlation coefficients can therefore be interpreted as reflecting the true degree of predictive validity of the ACB aptitude tests.

Table 4

RELATIONSHIP BETWEEN FINAL WRITTEN AND PERFORMANCE TESTS

Machinist Course (44E)

		Final Written Test			
		Below 70	70-84	85-100	Total
Final Performance Test	85 - 100	3	45	51	99
	70 - 84	6	100	43	149
	Below 70	8	46	27	81
	Total	17	191	121	329

r = .21

Fuel and Electrical System Repair Course (63G-Old)

		Final Written Test			
		Below 60	60-69	70 and above	Total
Final Performance Test	97 - 100	8	13	37	58
	92 - 96	24	25	34	83
	72 - 91[a]	25	20	10	55
	Total	57	58	81	196

r = .37

[a] No failing performance test grades

Small Arms Repair Course (45B)

		Final Written Test			
		Below 60	61-69	70 and above	Total
Final Performance Test	85 - 100	10	14	41	65
	70 - 84	57	67	70	194
	Below 70	6	8	8	22
	Total	73	89	119	281

r = .24

Fuel and Electrical System Repair Course (63G-New)

		Final Written Test			
		Below 50	50-69	70 and above	Total
Final Performance Test	95 - 100	4	23	10	37
	90 - 94	48	61	15	124
	80 - 89[a]	14	10	0	24
	Total	66	94	25	185

r = .47

[a] No performance grades below 80

The validity of the ACB in predicting course achievement was also determined separately for classes beginning early in the sampling period and those beginning later. The validity of the ACB was found to be lower for the later classes in the Machinist course, and the two sets of results are presented for this course. No differences were found for the Small Arms Repair course, and only the results for the total sample are presented. The Old and New Fuel and Electrical System Repair courses were analyzed and are reported separately.

The validity of the tests in the aptitude area scores used as prerequisites is shown in Table 5. Also shown is the validity of the General Information Test (GIT), which measures both general mental ability and mechanical ability. The tests in the aptitude area prerequisites for given courses had higher validity coefficients than the GIT for all courses except the more recent form of the Fuel and Electrical System Repair course where validity was about equal. The validity of the Pattern Analysis and Shop Mechanics tests, which make up the General Maintenance Aptitude Area, declined for the later classes in the Machinist course. The later classes graduated in the latter part of 1969, most of the earlier classes early in 1969. The validity of the General Information Test showed similar decline. Most of the other ACB tests also had lower validity for the later classes in the Machinist course. Apparently, some change occurred in this course that had the effect of reducing the predictive accuracy of the ACB tests.

The matrices were examined to determine whether meaningful patterns of correlation emerged. One facet examined was whether tests appropriate to a given course had the higher coefficients. In all cases, the tests in the aptitude area prerequisites for the courses had highest or close to highest validity. The tests measuring mechanical ability, such as the Mechanical Aptitude and Automotive Information tests, had higher validity than those of general mental ability, such as Verbal.

In respect to the validity profile of the tests for successive reporting periods, one hypothesis is that tests are valid for the initial periods of instruction, but then lose their validity as the training material begins to build on what was taught previously. An alternative hypothesis is that the validity of a test increases for later periods of instruction: If each unit builds on previous units in a cumulative manner and the able trainees master the successive steps while the dull ones fall progressively further behind, then the validity of relevant tests would increase. The validity profiles for the Machinist and Fuel and Electrical System Repair courses were generally flat, meaning that most ACB tests had relatively constant validity across time for these two courses. In these two courses, neither hypothesis about decreasing or increasing validity was supported. In the Small Arms Repair course, a consistent pattern of decreasing validity did emerge for the first eight written tests. The validity increased again for the final end-of-course written test. The same decreasing pattern emerged slightly when the performance tests were considered. It is possible that in the Small Arms Repair course the

Table 5

VALIDITY OF SELECTED ACB TESTS

	Tests		
	General Maintenance Aptitude Area		
Course	PA	SM	GIT
Machinist--Early	.62	.55	.47
Machinist--Late	.39	.42	.15
Small Arms Repair-Total	.58	.53	.50
	Motor Maintenance Aptitude Area		
	MA	AI	
Fuel and Electrical-Old	.71	.68	.64
System Repair-New	.54	.57	.60

nature of the instruction was such that learning the later materials required less of the aptitudes measured by the ACB. An examination of the curriculum would be required to support a hypothesis about the progression of learning.

The generally constant validity of the ACB tests supports their use as prerequisites. The appropriate tests were able to identify men who are likely to be successful. The tests were about equally effective throughout the course and for predicting final course grade. Since the tests generally had consistent predictive validity, one possibility for reducing failure rates is to increase the prerequisite score. The data were examined to determine the percentage of failures at different score levels on the aptitude area prerequisites. The results are presented in Table 6. In all three courses, some trainees were accepted who did not meet the established prerequisites. In all cases except the earlier form of the Fuel and Electrical System Repair course, the failure rate of these underqualified men was high, ranging from 38 percent to 44 percent. The total failure rate in the course was low, however, (6%), and there was no consistent drop in failures as prerequisite scores increased. In the Machinist course, the total failure rate was high, 16 percent, and in the GM score interval 115-119 the failure rate was still 10 percent.

While raising the prerequisite score would lower attrition in all courses, many men who successfully complete training would also be kept out; raising prerequisite scores would entail the cost of reducing the eligible manpower pool and produce a small reduction in the attrition rates.

Table 6

FAILURE RATES AT VARIOUS LEVELS OF APTITUDE AREA SCORES

Machinist Course (44E) Prerequisite GM 100			Small Arms Repair Course (45B) Prerequisite GM 95			Fuel and Electrical System Repair Course (63G-New) Prerequisite MM 95			Fuel and Electrical System Repair Course (63G-Old) Prerequisite MM 95		
Score	N	% Fail	Score	N	% Fail	Score	N	% Fail	Score	N	% Fail
Below 100	13	38	Below 95	23	43	Below 95	12	25	90-94	5	0
100-104	48	33	95-99	45	22	95-99	41	15	95-99	27	15
105-109	46	26	100-104	40	15	100-104	29	10	100-104	23	0
110-114	65	22	105-109	40	20	105-109	28	7	105-109	37	8
115-119	68	10	110-114	38	10	110-114	25	0	110-114	27	0
			115-119	35	08				115-119	27	4
Total	383	16	Total	310	14	Total	204	9	Total	210	6

CONCLUSIONS

Test scores provide critical data for making decisions about the success or failure of trainees. This research focused on the meaning of scores on achievement tests given during the course, especially as they impinge on decisions to fail trainees. The training process itself was not analyzed to determine the relationship between training and achievement measures, nor was any attempt made to determine absolute pass-fail standards. The tests were assumed to provide meaningful measures of the examinees' skills and knowledge, and the passing score as set by the school was accepted as the standard determining pass-fail. In subsequent research, the relationship between training grades and performance on the job will be analyzed. The appropriateness of passing standards can then be examined.

What is the primary determinant of failure in these courses? Failure generally hinges on achievement in the written tests administered at the end of the reporting periods. Failure rate on these tests was generally well over 10 percent--and occasionally over 50 percent--of all men who completed the course. On the performance tests, by contrast, trainees scored higher. On only two performance tests, both in the Machinist course, did failure rates exceed 20 percent.

The ACB tests could identify some of the failures, but raising the prerequisite scores would have small impact on the failure rates. These results suggest that the most fruitful strategy would be a thorough analysis of the written achievement tests to determine whether the minimum passing scores are realistic and to judge the correspondence between training materials and test content.

One possibility is to construct mastery achievement tests which would include tasks that all trainees should have mastered. The failures would then be trainees who do not have competence to perform at the minimal standard. Some difficult items could also be included to differentiate the most able trainees--for example, to pick out the top men. While some bright students may be motivated by difficult tests, slow and average students are more likely to be motivated by a feeling of success. If the written tests are designed to assess minimal acceptable standards, then failure rates will be lower and more men will have the experience of being successful.

The low degree of relationship between written and performance tests, both in terms of correlation and percentage of failures on each, raises questions about the meaning of the measures. Both types of test are estimates of the skills and knowledge covered during a particular reporting period. What are the conditions that lead to a trainee's doing well on one type but not on the other? An obvious explanation is that some men are good with practical, hands-on learning, while others are better with theory and concepts. Yet the lack of consistency in scores on the

performance test, as shown by their low intercorrelations, raises questions about their meaning. Performance tests were highly correlated with final course grades, but these were part-whole relationships, with the performance tests heavily weighted. Evidence seems to indicate that performance tests need improvement as evaluation tools.

Performance tests are receiving increasing emphasis in Army MOS training and in education in general. Their increased significance and low intercorrelation suggest that further research to improve their utility is warranted. Two immediate questions concern reliability of measurement: 1) How consistent are trainees in performing the same or similar tasks on separate occasions? 2) How consistent are the same or different observers in scoring trainee performance? Another question concerns the overlap between the tasks in performance tests and the training objectives: Do the tasks in performance tests adequately sample the range of skills and knowledge and can meaningful pass-fail distinctions be made? Since the decisions about trainees' scores on performance tests play such a significant role in evaluating their progress, a thorough understanding of the virtues and pitfalls of performance tests would help guide the instructional staff.

The effort to improve performance tests should be well worth the cost since they have such high face validity. Even as these tests now stand, the staff of the Ordnance School report that performance tests serve as good teaching devices by helping the trainee solidify what he has been taught. The research on performance tests could be directed to improve them as evaluation devices.

The ACB tests had higher validity for predicting grades on written tests than on performance tests. One reason is that both the aptitude and written tests are paper-and-pencil instruments that tap cognitive rather than motor skills. The question of reliability of performance tests, though, must be raised again in the context. If performance tests have low reliability, they cannot be predicted by any type of measure, including other performance tests. The lower intercorrelations among performance tests supports the hypothesis that performance tests are not even predictable by similar measures. From an instructional point of view, performance tests are excellent measures, because, after all, the objectives of training in these courses are to teach men to manipulate equipment. From a measurement point of view, however, decisions about the evaluation to place on trainee performance may not be as accurate as is expected from paper-and-pencil tests.

The next phase of this research project is to examine the relationships among aptitude tests, training grades, and performance on job tasks. Perhaps these analyses will increase our understanding of how written and performance tests function in the total process of classifying, training, and utilizing Army enlisted men.

An important function of achievement tests is to determine which students have developed an adequate level of skills and knowledge. Achievement tests are also used to make distinctions among those passing, for example, to assign grades of A, B, or C or to identify the top students in a class. The measurement instruments used are critical in assessing the students. The tests must be relevant to the material taught (a matter of expert judgment) and they must make adequate and reasonable discriminations among different levels of achievement. To make an intelligent judgment about the adequacy and reasonableness of tests applied in a course, an analysis of the scores is required. In the present phase of the research, the achievement test scores--written and performance--obtained at the end of each reporting period in three job training courses were analyzed in relation to each other, to final course grade, and to aptitude test scores obtained prior to training. The research was designed to provide data about the ways the tests are actually functioning. The results can be evaluated in the context of the instructional model on which the courses are based. The question is whether the results are in keeping with the instructional model or there is some dissonance between observed and expected outcomes.

APPENDIXES

Table A-1

GRADING PLAN FOR MACHINIST COURSE

Reporting Period	Length (in hours)	Weight (Percent)	Annex and Title	Graded Quiz No.	Graded Quiz Wt.	Homework	Written Examinations Lesson	Written Examinations Wt.	Performance Examinations Lesson	Performance Examinations Wt.
1	64	5	A Allied Sub	1	.5	.5	A-12	1.5		
				2	.5	.5	A-21	1.5		
2	36	9	A Allied Sub	3	.5	.5			A-24	8
3	28	8	B Bandsaw	4	.5	.5	B- 8	2.0	B- 7	5
4	46	8	B Shaper	5	.5	.5	B-18	2.0	B-17	5
5	47	3	C Basic Lathe	6	.5	.5	C-15	2.0		
6	77	3	C Intermed Lathe	7	.5	.5	C-25	2.0		
7	57	10	C Lathe Thread Opns	8	.5	.5	C-34	2.0	C-32	7
8	83	23	D Milling Opns	9	.5	.5	D-15	2.0	D-14	20
9	84	31	E Adv Lathe and EOCT	10	.5	.5	E-11	5.0	E- 5	25
Totals		100			5.0	5.0		20.0		70

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Table A-2

GRADING PLAN FOR SMALL ARMS MECHANIC COURSE (45B)

Course (Title and No) 641-45B20 Small Arms Repair   Effective With Class No 29/30

Taught By ________   Effective Date 18 Feb 69

Reporting Period	Length (in Hours)	Weight %	Annex and Title	Graded Quiz No.	Graded Quiz Wt	Written Examinations Lesson	Written Examinations Wt	Performance Examinations Lesson	Performance Examinations Wt	Other Graded Requirements Title	Other Graded Requirements Wt
1	29	11	M16 Rifle	1	01.0	E-1	2.0	E-11	8.0		
2	35	11	M14 Rifle and Pistol	2	01.0	E-2	2.0	E-10	8.0		
3	21	3	SMG GRE LAU and Shotgun	3	01.0	E-3	2.0				
4	29	4	Mortars	4&5	02.0	E-4	2.0				
5	33	3	BMG .30 & .50	6	01.0	E-5	2.0				
6	38	12	M60 & M73	7&8	02.0	E-6	.0	E-14	8.0		
7	39	3	M85 & M139	9	01.0	E-7	2.0				
8	27	3	REC WPNS	10	01.0	E-8	2.0				
9	29	50	E-O-C Wr & Perf			E-9	10.0	E-12 13, 15 E-17	24.0 16.0		
Totals	280	100			10.0		26.0		64.0		

Table A-3

GRADING PLAN FOR FUEL AND ELECTRICAL SYSTEM REPAIR COURSE (63G-Old)

Course (Title No) Fuel and Electrical Systems Repair Course 63G20-63A With Class No 13

Taught by Fuel and Electric Division Mobility Training Department Effective Date 6 Oct 67

Reporting Period	Length (in Hours)	Weight %	Annex and Title	Graded Quiz No	Graded Quiz Wt	Written Examinations No	Written Examinations Wt	Graded Pract. Exercises Lesson	Graded Pract. Exercises Wt	Performance Examinations Lesson	Performance Examinations Wt
1	24	4.5	A Allied Subjects B Intro to Auto	63G20-A-4, B-2&B-7	1.5	63G20-B-25	3.0				
2	22	5.5	C Fuel Sys W&T/V	63G20-C-7	.5	63G20-C-13	3.0	63G20-C-6&C-8	2.0		
3	46	9	C Fuel Sys W&T/V	63G20-C 14&C-20	1.0	63G20-C-21&C-32@3	6.0	63G20-C 16&C-30	2.0		
4	42	6	C Fuel Sys W&T/V	63G20-C-33&C-37	1.0	63G20-C-44	3.0	63G20-C-35&C-43	2.0		
5	28	6	C Fuel Sys W&T/V	63G20-C-45&D-1	1.0	63G20-C-52	3.0	63G20-C-47&C-51	2.0		
6	53	10	D&E Elec & Starting Sys	63G20-D-9&E-1	1.0	63G20-D-17&E-7@3	3.0	63G20-D-9, D-13&D-16	3.0		
7	46	10	F Ignition Sys	63G20-F-1&F-9	1.0	63G20-F-14	3.0	63G20-F-8&F-13	2.0	63G20-F-15	4.0
8	35	7	G Chg Sys W&T/V	63G20-G-2&G-19	1.0	63G20-G-12	3.0	63G20-G-4 G-6&G-11	3.0		
9	45	9.5	G Chg Sys W&T/V	63G20-G-13	.5	63G20-G-23&G-27@3	3.0	63G20-G-15, G-18&G-22	3.0		
10	40	10	G Chg Sys W&T/V	63G20-G-28&G-34	1.0	63G20-G-37	6.0	63G20-G-32&G-34	2.0	63G20-G-38	4.0
11	21	5.5	H Accessory Equip	63G20-H-1	.5	63G20-H-11	3.0	63G20-H 2&H-3	2.0		
12	13	17	EOC Examination			63G20-H-13	8.0			63G20-H-10	12.0
Totals	415	100			10.0		47		23		20

Table A-4

GRADING PLAN FOR FUEL AND ELECTRICAL SYSTEM REPAIR COURSE (63G-New)

Course (Title and No) Fuel and Electrical Systems Repair Course — Effective With Class No 55

Taught By Fuel and Electric Maintenance Div, Mob Tng Dept — Effective Date 28 Mar 69

Reporting Period	Length (in Hours)	Weight %	Annex and Title	Graded Quizzes No	Graded Quizzes Wt	Written Examinations Lesson No	Written Examinations Wt	Performance Examinations Lesson No	Performance Examinations Wt	Other Graded Requirements Title	Other Graded Requirements Wt
			A Allied Subjects								
1	67	10.0	B Intro to Auto Veh & Eng	2 @ 1	2.0	C-15	3	C-16	5		
			C Fuel Sys								
2	27	4.0	C Fuel Sys	1 @ 1	1.0	C-28	3				
3	77	15.0	C Fuel Sys	2 @ 1	2.0	C-51	3	C-52	10		
4	53	4.0	D Applied Electricity	1 @ 1	1.0	E-9	3				
			E Starting Sys								
5	47	14.0	F Ignition Sys	1 @ 1	1.0	F-16	3	F-17	10		
6	75	16.0	G Charging Sys	2 @ 1	2.0	G-21	3	G-22	11		
7	52	15.0	G Charging Sys	2 @ 1	2.0	G-37	3	G-38	10		
8	74½	22.0	H EOC Exam			H-12	6	H-10	16		
Totals	472½	100			11.0		27		62		

APPENDIX B - MEANS AND STANDARD DEVIATIONS OF GRADES

Table B-1

MEANS AND STANDARD DEVIATIONS OF VARIABLES IN TWO SAMPLES FOR MACHINIST COURSE (44E)

Variables	Mean A[a]	Mean B[b]	Std. Dev. A	Std. Dev. B
ACB Test				
VE	108.2	110.1	16.6	15.4
AR	108.6	111.2	15.8	13.7
SM	117.2	118.0	11.9	11.8
PA	113.6	114.9	15.6	15.4
ACS	108.9	110.5	15.4	14.4
AI	113.8	115.6	17.0	16.0
MA	111.2	113.2	16.8	15.9
ELI	111.3	113.5	17.3	16.2
GIT	106.4	108.3	14.8	13.4
CI	99.0	100.0	19.3	18.9
ARC	99.5	102.1	26.3	25.6
Written Test				
1	81.3	82.8	8.4	6.8
2	90.5	91.4	6.8	5.6
3	75.7	77.6	11.6	10.1
4	78.7	80.5	11.6	9.6
5	77.3	78.3	10.8	10.0
6	79.0	79.5	10.9	10.7
7	78.9	79.5	10.9	10.4
8	76.2	76.4	10.1	9.9
9	81.1	81.3	7.4	7.2
Performance Test				
2	83.1	83.8	6.2	5.8
3	83.7	85.2	13.3	11.8
4	77.1	79.4	14.9	12.4
7	80.6	81.1	13.3	12.7
8	82.1	82.2	9.9	9.8
9	76.6	77.1	13.4	12.7
Final Course Grade	78.4	80.5	8.0	6.2

[a]Sample A consists of all men who started Course 44E (N : 386)
[b]Sample B consists only of men who completed Course 44E (N : 333)

Table B-2

MEANS AND STANDARD DEVIATIONS OF VARIABLES IN TWO SAMPLES FOR SMALL ARMS REPAIR COURSE (45B)

Variables	Mean		Std. Dev.	
	A[a]	B[b]	A	B
ACB Test				
VE	111.9	112.9	20.9	20.6
AR	106.8	108.3	20.3	19.0
SM	111.0	111.6	14.2	14.1
PA	110.6	111.5	19.5	19.1
ACS	108.2	109.1	16.9	16.5
AI	105.1	106.0	16.7	16.4
MA	109.0	110.4	18.6	17.4
ELI	108.0	109.1	19.4	19.1
GIT	106.3	107.3	18.8	18.3
CI	102.9	103.9	22.4	22.3
ARC	98.5	99.6	28.1	27.8
Written Test				
1	74.5	75.3	14.4	14.1
2	76.4	77.3	15.1	14.6
3	77.2	77.4	14.3	14.4
4	74.6	75.3	14.7	14.3
5	71.0	71.9	15.5	15.2
6	81.2	81.9	12.7	12.1
7	85.1	85.4	11.6	11.5
8	76.1	76.9	13.5	12.9
9	66.2	66.7	11.6	11.4
Performance Test				
1	84.2	84.6	10.2	9.9
2	82.1	82.1	11.2	11.2
6	80.2	80.5	12.7	12.4
9	78.9	79.5	7.8	6.8
Final Course Grade	77.0	78.3	6.7	6.0

[a]Sample A consists of all men who started Course 45B (N : 312)

[b]Sample B consists only of men who completed Course 45B (N : 292)

Table B-3

MEANS AND STANDARD DEVIATIONS OF VARIABLES IN TWO SAMPLES FOR FUEL AND ELECTRICAL SYSTEM REPAIR COURSE (63G-01d)

Variables	Mean A[a]	Mean B[b]	Std. Dev. A	Std. Dev. B
ACB Test				
VE	103.4	104.6	18.4	18.0
AR	100.9	101.9	18.3	18.2
SM	108.2	109.3	16.1	15.5
PA	101.2	102.2	20.5	20.3
ACS	107.2	108.0	15.9	15.6
AI	114.4	115.5	14.5	13.5
MA	107.1	108.1	15.1	14.3
ELI	107.9	108.6	18.1	17.8
GIT	101.3	102.2	15.5	14.9
CI	95.9	96.5	17.4	16.9
ARC	97.2	98.1	27.2	27.1
Written Test				
1	87.6	88.2	9.1	8.7
2	86.2	87.3	12.2	11.1
3	76.5	77.2	12.8	12.4
4	75.3	75.5	14.7	14.8
5	72.5	72.7	16.3	16.4
6	78.5	78.8	12.1	11.9
7	69.6	69.6	15.2	15.2
8	79.6	79.6	11.3	11.3
9	75.7	75.7	12.3	12.3
10	78.0	78.0	11.1	11.1
11	80.5	80.4	15.4	15.4
12	67.3	67.3	10.8	10.8
Performance Test				
8	94.1	94.1	6.8	6.8
11	95.0	95 0	7.3	7.3
12	93.3	93.3	5.0	5.0
Final Course Grade	81.1	82.1	6.8	5.5

[a]Sample A consists of all men who started Course 63G-Old (N : 212)
[b]Sample B consists only of men who completed Course 63G-Old (N : 200)

Table B-4

MEANS AND STANDARD DEVIATIONS OF VARIABLES IN TWO SAMPLES FOR FUEL AND ELECTRICAL SYSTEM REPAIR COURSE (63G-New)

Variables	Mean A[a]	Mean B[b]	Std. Dev. A	Std. Dev. B
ACB Test				
VE	99.3	100.2	18.7	18.2
AR	98.9	100.0	18.4	17.9
SM	104.6	104.6	16.1	16.0
PA	98.7	99.3	21.7	21.3
ACS	103.3	103.4	18.5	18.4
AI	112.1	112.6	15.0	14.9
MA	105.1	105.7	15.3	15.2
ELI	103.3	104.1	17.3	17.2
GIT	98.3	99.1	16.0	15.8
CI	92.2	92.3	20.4	20.7
ARC	92.4	93.4	28.3	28.5
Written Test				
1	71.0	72.1	14.2	13.3
2	71.6	72.7	15.2	14.0
3	71.2	71.4	15.9	15.9
4	73.9	74.0	15.1	15.1
5	72.1	72.2	14.2	14.2
6	62.0	62.0	10.8	10.8
7	57.3	57.3	13.2	13.2
8	55.8	55.8	12.2	12.2
Performance Test				
1	90.8	91.0	6.5	6.5
3	96.8	96.9	4.4	4.4
5	94.1	94.1	5.5	5.5
6	89.3	89.4	10.4	10.4
7	94.6	94.6	5.2	5.2
8	93.6	93.6	3.8	3.8
Final Course Grade	81.9	83.4	6.6	4.4

[a]Sample A consists of all men who started Course (63G-New (N : 204)

[b]Sample B consists only of men who completed Course 63G-New (N : 187)

APPENDIX C - CORRELATION COEFFICIENTS FOR COURSES

Table C-1

CORRELATION COEFFICIENTS FOR MACHINIST COURSE (44E-EARLY)

	Mean Correlation		
	Written Tests	Performance Tests	Final Course Test
Written Test			
1	.64	.48	.73
2	.35	.28	.40
3	.62	.48	.71
4	.64	.48	.73
5	.62	.50	.76
6	.58	.47	.71
7	.60	.41	.64
8	.60	.41	.66
9	.55	.40	.63
Performance Test			
2	.45	.46	.69
3	.36	.30	.46
4	.50	.48	.72
7	.36	.34	.56
8	.47	.47	.78
9	.47	.48	.88
ACB Test			
VE	.53	.30	.48
AR	.53	.33	.49
SM	.45	.39	.55
PA	.51	.44	.62
ACS	.30	.20	.27
AI	.44	.36	.48
MA	.54	.44	.62
ELI	.45	.34	.50
GIT	.50	.30	.47
CI	.33	.28	.36
ARC	.39	.29	.42

Table C-2

CORRELATION COEFFICIENTS FOR MACHINIST COURSE (44E-LATE)

	Mean Correlation		
	Written Tests	Performance Tests	Final Course Grade
Written Test			
1	.59	.36	.67
2	.21	.10	.18
3	.53	.27	.52
4	.61	.33	.65
5	.56	.32	.62
6	.60	.35	.70
7	.55	.23	.52
8	.54	.23	.52
9	.59	.34	.63
Performance Test			
2	.07	.18	.27
3	.29	.27	.48
4	.43	.36	.69
7	.30	.35	.62
8	.25	.35	.70
9	.34	.40	.87
ACB Test			
VE	.44	.07	.24
AR	.54	.22	.47
SM	.38	.26	.42
PA	.45	.23	.39
ACS	.25	.07	.18
AI	.34	.24	.36
MA	.45	.29	.45
ELI	.42	.22	.40
GIT	.35	.06	.15
CI	.24	.15	.28
ARC	.38	.16	.31

Table C-3

CORRELATION COEFFICIENTS FOR SMALL ARMS REPAIR COURSE (45B)

	Mean Correlation		
	Written Tests	Performance Tests	Final Course Grade
Written Test			
1	.43	.35	.61
2	.46	.37	.64
3	.40	.35	.58
4	.42	.27	.54
5	.44	.33	.60
6	.41	.37	.61
7	.38	.34	.57
8	.30	.20	.40
9	.45	.34	.67
Performance Test			
1	.32	.40	.64
2	.32	.36	.60
6	.26	.39	.61
9	.39	.46	.83
ACB Test			
VE	.41	.24	.51
AR	.41	.25	.51
SM	.34	.36	.53
PA	.37	.38	.58
ACS	.22	.22	.38
AI	.30	.27	.43
MA	.40	.37	.59
ELI	.35	.29	.49
GIT	.39	.26	.50
CI	.21	.13	.30
ARC	.28	.26	.42

Table C-4

CORRELATION COEFFICIENTS FOR FUEL AND ELECTRICAL SYSTEM REPAIR COURSE (63G-OLD)

	Mean Correlation		
	Written Tests	Performance Tests	Final Course Grade
Written Test			
1	.57	.33	.71
2	.57	.31	.72
3	.66	.43	.85
4	.59	.39	.76
5	.58	.40	.76
6	.62	.36	.79
7	.57	.39	.73
8	.68	.47	.87
9	.61	.40	.80
10	.61	.40	.79
11	.54	.39	.72
12	.69	.47	.91
Performance Test			
8	.48	.48	.65
11	.23	.31	.36
12	.47	.45	.66
ACB Test			
VE	.54	.23	.64
AR	.58	.33	.71
SM	.48	.33	.61
PA	.45	.25	.55
ACS	.31	.26	.39
AI	.52	.41	.68
MA	.55	.41	.71
ELI	.52	.28	.64
GIT	.57	.33	.70
CI	.29	.21	.37
ARC	.36	.22	.44

Table C-5

CORRELATION COEFFICIENTS FOR FUEL AND ELECTRICAL SYSTEM REPAIR COURSE (63G-NEW)

	Mean Correlation with Training Performance		
	Written Tests	Performance Tests	Final Course Grade
Written Test			
1	.68	.39	.83
2	.61	.31	.73
3	.65	.40	.81
4	.54	.30	.67
5	.68	.38	.82
6	.67	.39	.82
7	.65	.38	.80
8	.70	.41	.87
Performance Test			
1	.09	.09	.17
3	.26	.20	.39
5	.51	.33	.70
6	.38	.27	.62
7	.37	.28	.54
8	.60	.40	.80
ACB Test			
VE	.50	.29	.60
AR	.55	.35	.67
SM	.47	.25	.55
PA	.42	.29	.53
ACS	.27	.23	.36
AI	.51	.23	.57
MA	.46	.26	.54
ELI	.48	.23	.54
GIT	.50	.29	.60
CI	.21	.12	.27
ARC	.29	.18	.35

APPENDIX D

PREDICTING FINAL COURSE GRADE FROM GRADES IN REPORTING PERIODS

An important question from the instructional staff point of view is how early in training courses the eventual failures can be identified. If the failures can be identified early, then they can be sent to other courses where they are more likely to succeed. Both the man and school would benefit from early transfer before both have a large investment in a course where the likely outcome is a failure.

The identification of early failures was examined via the correlation between scores on written and performance tests given at the end of reporting periods and final course grades. The sums of the examination grades through each reporting period were correlated with final course grade, and the results are shown in Table D-1. The first row shows the correlation coefficients of the examination of reporting period 1 with final course grade. The second row shows the correlation of the sum of examination scores of reporting periods 1 and 2. In subsequent rows, the scores for additional reporting periods were added, until, in the final row, the examination scores for all reporting periods were added together. Correlation coefficients began at about .6 for period 1 and increased to about .9 or above for the sum of all scores through the final period.

Table D-1

Correlation of Sum of Examinations with Final Course Grade

Reporting Periods	Course Examinations 44E	45B	63G New
1	.60	.67	.66
1+2	.65	.77	.72
1+2+3	.70	.76	.81
1-4	.80	.76	.82
1-5	.81	.79	.87
1-6	.82	.85	.92
1-7	.85	.86	.94
1-8	.88	.86	.95
1-9	.94	.89	

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The following chart can be used to interpret the meaning of the correlation coefficients for identifying men who will fail the course. Four levels of correlation between examination scores and final course grade are shown. Three levels of failure on examinations are also shown: 7%, fairly easy examinations; 16%,moderately difficult; and 30%, a difficult examination. The failure rate for the course was set at 16%, which is about the average for the three courses in this research. The cell entries show the percentage of men expected to fail both the examination and the course.

% that fail examination

		7%	16%	30%
correlation	.60	04%	07	11
with final	.70	05	08	12
course grade	.80	05	10	14
	.90	06	12	15

The first cell entry, 4%, means that of the 7% that fail the examination, 4% would also eventually fail the course, and the remaining 3% would improve their grades and pass the course. An additional 12% who passed this examination would fail subsequent examinations and eventually the course. As the correlation increases, the accuracy of preiiction increases. As the percentage of failures on an examination increases, so does the proportion of those who fail the course. When the failure rate on the examination is 30% and correlation with final course grade is r=.90, then 15% of the eventual failures would be identified; only 1% of the course failures would pass the early examination. But, of course, another 15% that failed the examination completed the course successfully.

The chart can be used to estimate the proportion of course failures. The data required are the correlation of the sum of the examination scores with final course grade and the percentage that has failed the examinations; the failure rates for the separate examinations will need to be averaged if more than one is included. If the failure rate for a course differs somewhat from 16%, say, plus or minus 10%, then the cell entries can be changed proportionally; or if the failure rates on examinations fall between 7% and 30%, the cell entries can be used to estimate the proportion that fail both the examinations and course. Since the relationships are not linear, extreme deviations are not proportional to the tabled entries. A new table would need to be prepared from the normal bivariate tables for different failure rates.